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SOME MODERN CONCEPTIONS OF AMEBIASIS[1]

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INTRODUCTION

IN 1875 a Russian physician, F. Lösch, first observed and described the active stage of *Endamoeba histolytica* in the dysenteric stools of a patient, and at necropsy found motile amebae in material obtained from ulcers of the colon. Moreover, he succeeded in infecting one of four dogs inoculated with amebae present in the bloody-mucous exudate of the patient. Yet Lösch failed to appreciate the role which his "Amoeba coli" played in the disease with which it was associated. The studies of Koch[2] and of Kartulis[3a,b] in Egypt, of Hlava[4] in Prague, of Osler,[5] Stengel,[6] Musser[7] and Dock[8] in the United States provided uncontestable evidence that the ameba discharged in dysenteric stools was causally related to amebic colitis, while Quincke and Roos,[9] Huber[10] and Schaudinn[11] demonstrated a cystic stage of the parasite. Meanwhile Councilman and Lafleur[12] had provided a basic pathological study of amebiasis and in 1913 Walker and Sellards demonstrated experimentally in human volunteers in the Philippines that the disease was produced by feeding cysts of *Endamoeba histolytica,* while infection without disease resulted from feeding cysts of *Endamoeba coli.* By 1924

[1] Alvarenga Prize Lecture of the College of Physicians of Philadelphia, delivered on October 13, 1943.

[2] R. Koch, *Wien. Med. Wochenschr.,* 33: 1248–1252; 1548–1551, 1883.

[3a] S. Kartulis, *Arch. f. path. Anat.,* 105: 521–531, 1886; b. *Centralbl. f. Bakt. u. Parasitenkde.,* 2: 745–748, 1887.

[4] O. Hlava, *Zeitschr. d. böhm. Aerzte in Prag.,* 1887.

[5] Wm. Osler, *Johns Hopkins Hosp. Reports,* 1: 53–54, 1890.

[6] A. Stengel, *Med. News, Phila.,* 57: 500–503, 1890.

[7] J. H. Musser, *Univ. Med. Mag.,* Phila. 9 pp., 1890.

[8] G. Dock, *Med. Record,* N. Y., 40: 7–8, 1891.

[9] H. Quincke and E. Roos, *Berlin klin. Wochenschr.,* 30: 1089–1094, 1893.

[10] J. C. Huber, *Deutsch. Med. Wochenschr.,* 29 (Beih.): 267, 1903.

[11] F. Schaudinn, *Arb. aus d. kaiserl. Gesundh.-Amte,* 19: 547–576, 1903.

[12] W. T. Councilman and H. A. Lafleur, *Johns Hopkins Hosp. Reports,* 2: 395–548, 1891.

Boeck and Drbohlav[13] had perfected a technique for the *in vitro* cultivation of *E. histolytica* and by 1927 Craig[14] had demonstrated specific complement-fixing properties of *E. histolytica* antigen.

During this period of approximately fifty years the ideas that amebiasis was strictly or primarily a tropical disease and usually manifested itself as a fulminating dysentery or a liver abscess became gradually modified. Little by little, as epidemiologic studies were carried out, the discovery was made that amebiasis is practically cosmopolitan in its distribution, although as a rule its incidence is higher and its clinical expressions are more severe in the Tropics than in cooler climates. Dysentery and liver abscess were found to be only two of its more dramatic manifestations. There might be a history of an acute or subacute appendicitis or of general colonic distress without dysentery or even without diarrhea. There might be no apparent intestinal disturbance but a mild toxic state, with moderate leukocytosis and a low-grade fever. The patient might be considered symptomless by the uncritical diagnostician and yet at necropsy extensive amebic ulceration of the colon might be demonstrated. Throughout this period both by direct and indirect methods there developed increasing evidence that *Endamoeba histolytica* is always actually or potentially a pathogen and that it is capable of invading and destroying the host's tissue without the aid of pathogenic bacteria.

Hosts of Endamoeba histolytica

In addition to man the following hosts have been described as infected in nature or susceptible of experimental infection with *Endamoeba histolytica*—dogs, cats, monkeys, rats, pigs, guinea-pigs and rabbits.

Darling,[15] Ware,[16] Fischer,[17] Bausche and Motais,[18] Faust[19, 20] and Boyd[21] have described spontaneous amebiasis in dogs either in isolated instances or in epidemics among small groups of dogs. Lösch,[22] Hlava,[4] Harris,[23] Dale and Dobell,[24] Andrews,[29] Faust,[19, 20, 25, 26, 27, 28] Swartzwelder[30] and Tobie[31] have demonstrated the infectibility of dogs with trophozoites or cysts of human strains of *E. histolytica*. On the basis of previously published data and extensive personal observations Faust[26] concluded that dogs usually obtain their infection from man but do not constitute a normal source of exposure for human beings. The lesions in the dog may be few and superficial or extensive and deep-seated. The symptoms may be acute or chronic or spontaneous recovery may result after a short period of colonization by the amebae in the bowel wall. Occasionally liver abscess may develop following invasion of the intestine.

Many workers have infected kittens with human strains of *E. histolytica*. Among the more important investigators have been Marchoux,[32] Craig,[33] Wenyon,[34] Baetjer and Sellards,[35] Dale and Dobell,[24] Kessel,[36] Rees,[37] Meleney and Frye[38] and Deschiens.[39] Kittens develop a fulminating, frequently fatal amebic dysentery and are therefore excellent for acute experiments. There appear to be no records of their infection in nature.

Many species of Old and New World monkeys are naturally infected with strains of *Endamoeba histolytica* indistinguishable from those occurring in man. The incidence of natural infection in these animals is usually high, while experimentally induced infection with simian or human strains is easily accomplished. Although amebic invasion of the monkey's large bowel has been demonstrated[40] the parasite usually lives in relative equilibrium with its simian host so that acute symptoms seldom develop.

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[13] W. C. Boeck and J. Drbohlav, *Am. Jour. Hygiene*, 5: 371–407, 1925.

[14] C. F. Craig, *Am. Jour. Trop. Med.*, 7: 225–240, 1927.

[15] S. T. Darling, *Proc. Canal Zone Med. Assn.*, 6: 60–62, 1915.

[16] F. Ware, *Jour. Comp. Path. and Therap.*, 19: 126–130, 1916.

[17] W. Fischer, *China Med. Jour.*, 32: 13–20, 1918.

[18] J. Bausche and F. Motais, *Bull. Soc. Path. Exot.*, 13: 161–165, 1920.

[19] E. C. Faust, *Proc. Soc. Exp. Biol. and Med.*, 27: 908–911, 1930.

[20] E. C. Faust, *Porto Rico Jour. Pub. Health and Trop. Med.*, 6: 391–400, 1931.

[21] J. S. K. Boyd, *Jour. R. Army Med. Corps*, 56: 1–13, 1931.

[22] F. Lösch, *Arch. of path. Anat.*, 65: 196–211, 1875.

[23] H. F. Harris, "On the Alterations Produced in the Large Intestine of Dogs by the *Amoeba coli*, by Heat and by Various Chemic Substances. Phila. 143 pp., 1901.

[24] H. H. Dale and C. Dobell, *Jour. Pharmacol. and Exp. Therap.*, 10: 399–459, 1917.

[25] E. C. Faust, *Am. Jour. Trop. Med.*, 11: 231–237, 1931.

[26] E. C. Faust, *Proc. Soc. Exp. Biol. and Med.*, 29: 659–661, 1932.

[27] E. C. Faust, *Jour. Pediat.*, 2: 53–58, 1933.

[28a] E. C. Faust and E. S. Kagy, *Am. Jour. Trop. Med.*, 14: 221–233, 1934; b. 14: 235–255, 1934.

[29] J. Andrews, *Am. Jour. Trop. Med.*, 12: 401–404, 1932.

[30] J. C. Swartzwelder, *U. S. Pub. Health Reports*, 52: 1447–1451, 1937.

[31] J. E. Tobie, *Proc. Soc. Exp. Biol. and Med.*, 45: 691–693, 1940.

[32] E. Marchoux, *Compt. Rend. Soc. biol. Paris*, 51: 870–871, 1899.

[33] C. F. Craig, *Am. Med.*, Phila., 9: 854–861; 897–903; 936–942, 1905.

[34] C. M. Wenyon, *Jour. London School Trop. Med.*, 2: 27–, 1912.

[35] W. A. Baetjer and A. T. Sellards, *Johns Hopkins Hosp. Reports*, 25: 234–241, 1914.

[36] J. F. Kessel, *Am. Jour. Hyg.*, 8: 311–355, 1928.

[37] C. W. Rees, *Arch. Path.*, 7: 1–26, 1929.

[38a] H. E. Meleney and W. W. Frye, *Am. Jour. Hyg.*, 17: 637–656, 1933; b. 25: 313–327, 1937.

[39] R. E. A. Deschiens, *Compt. Rend. Soc. biol. Paris*, 127: 939–941, 1938.

Pigs, guinea-pigs, rabbits and rats are probably incidental hosts of *Endamoeba histolytica* and in nature apparently play no important role as reservoirs of the infection.

Sources and Methods of Exposure to Infection

On the basis of information concerning amebic infection in hosts other than man it must be concluded that man is primarily, in fact, almost exclusively responsible for his own infection. Although it has been demonstrated experimentally[22, 30] that infection in dogs can be accomplished by feeding the trophozoites in a bloody-mucous menstruum, it is hardly conceivable that this stage serves as a source of human infection. On the other hand, there is a wealth of records of infection in susceptible experimental animals, which, with the critical experiments of Walker and Sellards[41] on human volunteers, demonstrates that cysts constitute a ready source of infection, and that the method of their entry into the body is by the oral route.

In what way or ways do cysts of *Endamoeba histolytica,* discharged from the bowels of infected individuals, reach the human mouth? The most common hypotheses predicate water, food, flies and contact contamination. While each of these hypotheses fits well into the epidemiology of amebiasis, there is a paucity of direct proof for any one of them.

The *water hypothesis* is supported by circumstantial evidence, and hence indirect proof, in the case of the hyperendemicity of amebic dysentery in Manila and the Panama Canal Zone in the early days of American occupation, together with a marked diminution in the incidence and the intensity of the disease soon after the installation of sanitary water and sewerage systems in these localities. Moreover, the report of specialists in the 1933 Chicago hotel outbreak of amebic dysentery (Bundesen *et al.*)[41] concluded that drinking water contaminated by cross-connections with sewage pipes was responsible for the epidemic. One member of the investigating committee, the late Dr. F. W. O'Connor, lived in the hotel for one month, drank water from the faucet in his room and acquired amebic dysentery with amebic liver abscess. Although these are very important epidemiologic data, the fact remains that in none of these instances were cysts of *Endamoeba histolytica* reported to have been actually isolated from the contaminated water. Again, it is also plausible, but not confirmed, that shallow wells in rural areas may serve as a source of infection for the amebiasis which is widely disseminated throughout the Southeastern United States.

The *food hypothesis* is accepted by many epidemiologists as the most satisfactory explanation for the extensive distribution of amebiasis. In Oriental countries where truck crops and small fruits are fertilized with human nightsoil, it is conceivable that infection may be acquired from eating raw lettuce, celery, radishes and strawberries, provided fermentation of the nightsoil or desiccation of the cysts does not kill the cysts. A more likely contamination of food is that due to food handlers. Milam and Meleney[42] found a correlation between *E. histolytica*-infected mothers in rural Tennessee and familial amebiasis. Schoenleber[43] found that anti-amebic treatment of *E. histolytica*-positive food handlers on the island of Aruba, off the coast of Venezuela, reduced both the incidence rate of amebiasis and the amebic colitis rate 92 per cent. in three years. Surveys on food handlers in Chicago,[44] in San Francisco[45] and in Philadelphia,[46] have demonstrated a higher incidence of amebiasis in this group than in the population at large, but Sapiro and Johnson[47] found no evidence in navy personnel that food handlers constituted any particular hazard in the dissemination of the infection.

The *fly hypothesis* has not been given as great emphasis as the two views previously considered. In city populations essentially free of the dangers of filth flies this hypothesis obviously is not tenable, but in rural areas and throughout the Tropics and the Orient there is circumstantial evidence that flies may play the essential role in the rapid dissemination of the disease. Craig[48] attributed an epidemic of amebic dysentery in an Army post at El Paso, Texas, to flies. The writer made a similar observation in a foreign hill station in China during the summer of 1921. Moreover, amebiasis is particularly prevalent in fly-infested regions from Morocco to Peking. Thomson and Thomson,[49] Wenyon and O'Connor,[50] Roubaud,[51] Root[52] and Pipkin[53] have demonstrated viable cysts of *E.*

[40] C. M. Johnson, *Am. Jour. Trop. Med.,* 21: 49–58, 1941.

[41] E. L. Walker and A. T. Sellards, *Philip. Jour. Sci.* (*B*), 8: 253–331, 1913. H. N. Bundesen, J. I. Connolly, I. D. Rawlings, A. E. Gorman, G. W. McCoy and H. V. Hardy, *Nat. Inst. Health Bull.* No. 166, pp. 187, Washington, D. C., 1936.

[42] D. F. Milam and H. E. Meleney, *Am. Jour. Hyg.,* 14: 325–336, 1931.

[43] A. W. Schoenleber, *Jour. Trop. Med. and Hyg.,* 44: 41–43, 1941.

[44] M. Hood, *Am. Jour. Trop. Med.,* 23: 327–332, 1943.

[45] H. G. Johnstone and M. K. Iverson, *Am. Jour. Trop. Med.,* 15: 197–209, 1935.

[46] D. H. Wenrich, R. M. Stabler and J. H. Arnett, *Am. Jour. Trop. Med.,* 15: 331–345, 1935.

[47] J. J. Sapiro and C. M. Johnson, *Am. Jour. Trop. Med.,* 19: 255–265, 1939.

[48] C. F. Craig, *Mil. Surgeon,* 40: 286–302, 1917.

[49] D. Thomson and J. D. Thomson, *Jour. R. Army Med. Corps,* 27: 1–31, 1916.

[50] C. M. Wenyon and F. W. O'Connor, "Human Intestinal Protozoa in the Near East." London. 218 pp., 1917.

[51] E. Roubaud, *Bull. Soc. Path. Exot.,* 11: 116–171, 1918.

[52] F. M. Root, *Am. Jour. Hyg.,* 1: 131–153, 1921.

histolytica in both the gut and dejecta of flies after experimental feedings, while Frye and Meleney[54] found that flies caught in four of twelve dwellings which housed human cyst passers contained viable cysts of *E. histolytica.*

The *direct contact hypothesis* is probably applicable to a wide range of unsanitary situations in warm moist climates but in cooler climates may also apply, particularly to institutional groups, as children's asylums, mental hospitals and prisons. Outbreaks of amebic dysentery in prisons are much more frequent than the medical literature indicates. Mental hospitals have been found to be particularly afflicted with amebiasis from Panama[55] to Sweden,[56] and the infection has been found in children's homes from New Orleans to Saskatoon.[57] In New Orleans several children's homes and one infant asylum have been studied by the Department of Tropical Medicine of Tulane University since 1929. In all these institutions the incidence was found to be high, beginning with children slightly over one year of age and increasing rapidly to the period of adolescence (Faust).[27] Epidemiologic studies carried out at the infant asylum[57a] have demonstrated that identifiable cysts of *Endamoeba histolytica* were recoverable from the bottom of the laundry chute, from underpanties washed in tepid water, from play objects, floors and from the bottom of the children's wading pool. Although the place was apparently clean and the water supply was uncontaminated, a careful study of the habits of the children showed that direct contact contamination was prevalent. In certain mental hospitals and prisons the opportunities for gross transfer of amebic cysts from one individual to another are much greater than in the average children's home.

An examination of the evidence concerning the methods of exposure to amebiasis leaves much to be demonstrated. Without being hypercritical the student of scientific medicine will reserve judgment until more direct proof has been presented as to how in each situation amebiasis is actually perpetuated.

PATHOGENESIS

The stage of *Endamoeba histolytica* most likely to produce infection in man is the freshly ripened four-nucleate cyst, which is present in formed stools of infected individuals within a few hours after the stools have been passed. If these cysts gain entry to the mouth and are swallowed, they pass unmodified through the stomach into the small bowel. On arrival in a neutral or slightly alkaline medium of the latter the four-nucleate organism within the cyst wall becomes activated while the wall itself becomes weakened. This characteristically results in the ameba affecting an escape through a little rent in the wall. Thereupon a small amount of cytoplasm becomes associated with each of the four nuclei (or at times a supernumerary division of the nuclei may occur), with the result that four- or eight-minute metacystic trophozoites are formed. These trophozoites now pass down the remaining portion of the ileum, through the ileo-cecal valve and into the large bowel.

Stasis of material *en transit* through the intestine normally first occurs at the level of the cecum. If the metacystic trophozoites come in contact with the cuticula of the intestinal epithelium at this level for only a short time (probably measurable in minutes), they are enabled to establish a little "foothold," which constitutes their *entree* to tissue invasion. At times they may be swept past the cecum into the colon or rectum, where they may become attached, or perchance they may be passed out the anus in feces without having had an opportunity to make tissue contact.

The exact method by which the trophozoites establish themselves in the mucosa of the large bowel has been studied experimentally in dogs,[28] kittens[37, 58] and monkeys,[59] and is parallel in human amebiasis.[60] By lysis a very small cavity is produced in the superficial portion of a principal or gland cell. This may occur with equal likelihood at the tip of an interglandular prominence, part way down the crypt or at the base of the crypt. By continued lytic action, aided at times by mechanical activity of the pseudopodia, the ameba continues its invasion into the cell, utilizing the digested cell substance as food. Following growth, it multiplies by binary fission and thus a small colony becomes established. If these various factors are optimal, the colony may be formed within twenty-four hours or less after initial contact with the surface of the mucosa.

Once entry into the intestinal epithelium has been effected and the colony has started, the direction of tissue penetration and destruction is towards and through the muscularis mucosae. If lodgment was originally secured part way down a crypt, destruction of the superficial portion of the cells continues to the base. If the colony first became established at the base of the crypt, erosion of cells in this area occurs. In neither case do the amebae immediately

[53] A. C. Pipkin, *Proc. Soc. Exp. Biol. and Med.*, 49: 46–48, 1942.
[54] W. W. Frye and H. E. Meleney, *Jour. Parasitol.*, 18: 118, 1931.
[55] S. T. Darling, *Proc. Canal Zone Med. Assn.*, 4: (1), 41–47, 1911.
[56] R. M. Svensson, *Parasitol.*, 20: 237, 1928.
[57] M. J. Miller, *Jour. Parasitol.*, 25: 355–357, 1939.
[57a] G. L. Ivanhoe, *Am. Jour. Trop. Med.*, 23: 401–419, 1943.
[58] K. Hiyeda, *Am. Jour. Hyg.*, 12: 401–423, 1930.
[59] R. Hegner, C. M. Johnson and R. M. Stabler, *Am. Jour. Hyg.*, 15: 394–443, 1932.
[60] W. M. James, *Ann. Trop. Med. and Parasitol.*, 22: 201–225, 1928.

come in contact with intestinal blood capillaries and thus rather extensive destruction may occur in a limited area without hemorrhage. If, on the other hand, the original site of colonization was at the tip of an interglandular prominence, the amebae come in contact with blood capillaries as soon as they penetrate into the tunica propria below the epithelium, so that early hemorrhage results. In the average case the lesion progresses unhindered as a more or less capillary column until it reaches the muscularis mucosae where somewhat more resistant tissue is encountered. This causes a temporary pyramiding of the amebae, but soon some of them break through into the submucosa. There is now a tendency for the amebae to progress radially in this less resistant tissue, frequently gaining entrance into lymphatic capillaries and at times invading mesenteric venules. The usual result is the enlargement of the lesion basally in the submucosa, so that in section it is similar to a bottle with a narrow neck and expanded base. This is the typical uncomplicated amebic lesion.

At times in man, the monkey and the dog the lesion may be confined to the mucosa, in which case tissue destruction may be very superficial and spontaneous evacuation of the colony may occur with healing by growth of simple columnar epithelium.[31] Or repair may keep up with tissue destruction and only shallow microscopic depressions or craters will result.[61] In kittens much more intensive destruction usually occurs.

These uncomplicated amebic lesions are essentially different from those produced by *Shigella dysenteriae*. In primary amebiasis the sites of entry into the bowel wall are typically pinpoint and separated from one another, with a raised annulus surrounding each opening. There is little, if any, hyperemia or inflammation and microscopically there is no infiltration of neutrophiles. In bacillary colitis the surface of the bowel is hyperemic and inflamed and the lesions are confluent, while microscopically there is extensive invasion of neutrophiles. The amebic lesion is typically columnar in the mucosa but is continued into a bulbar base in the submucosa. The lesion of *Shigella* colitis rarely extends below the superficial half of the mucosa.

Once the characteristic bottle type of amebic lesion has been developed it may by extension reach the muscular coats of the bowel and even perforate through the serosa. Amebae which have secured entry into mesenteric venules in the submucosa and muscularis may be carried to the liver, where they may set up multiple small colonies (amebic hepatitis) or one or more large cavernous abscesses. Again, extensive colonization in the submucosa may result in undermining tunnels, with the junction of adjacent colonies and complete loss of arteriolar blood supply for the overlying tissues. Amebae extruded from primary lesions in the upper levels of the large bowel may by regurgitation be carried back to the posterior segment of the ileum or become lodged on the ileo-cecal valve where secondary lesions may develop. Or, perhaps more often, the organisms will pass down the bowel, come in contact with the mucosa at lower levels and there initiate secondary colonies.

In the average host parasitized by *Endamoeba histolytica* the majority of primary lesions occurs in the cecal area, including the cecum, appendix, the distal segment of the ileum and the ascending colon. The other focus of high frequency is the rectal area, including the sigmoid colon and the rectum. Even after numerous secondary lesions have been developed the cecal area still contains a preponderance of the total number of lesions.[61] Except in fulminating acute amebiasis or infections of long-standing the middle segment of the large bowel is only incidentally involved.

Although it has been demonstrated that bacteria are not necessary for successful entry of *Endamoeba histolytica* into the bowel wall,[62, 63] the older amebic ulcers are frequently complicated by bacterial invasion. Moreover, amebic colitis may be superimposed on a pre-existing *Shigella* colitis or *vice versa*.

It will next be useful to inquire into the chances of infection and of tissue invasion by *Endamoeba histolytica*. Infection is contingent on a number of factors which vary considerably under different conditions. First of all is the question of exposure. Qualitatively there must be viable organisms which have an opportunity of gaining entrance to the mouth and of being swallowed. On reaching the small bowel cysts must be capable of excysting. If the medium is too acid or the intestinal juices are too weak or are diluted too much by food in the process of digestion it is altogether likely that excystation will not occur and thus the cysts will pass through the large bowel and be evacuated without providing an opportunity for an infection to become established. Even though excystation occurs, if the number of metacytic trophozoites is scant the chances of their coming in contact with the cuticular surface of the epithelium of the large bowel are very remote, particularly if they are in the midst of a considerable menstruum of partly digested food or feces. Moreover, hypertonicity of the bowel is likely to carry the organisms through the bowel too rapidly for them to make temporary contact with the mucosal surface. Probably human beings in mildly endemic areas are often exposed to a few viable cysts which actually excyst in the ileum

[61] E. C. Faust, *Am. Jour. Trop. Med.*, 21: 35–48, 1941.

[62] E. C. Faust and J. C. Swartzwelder, *Proc. Soc. Exp. Biol. and Med.*, 32: 954–958, 1935.

[63] W. W. Frye and H. E. Meleney, *Am. Jour. Hyg.*, 18: 543–554, 1933.

but never have an opportunity to colonize in the bowel. On the other hand, in areas of hyperendemicity repeated exposure to large numbers of viable cysts provides the appropriate setting for development of heavy infections in a large group of the population.

The virulence of the particular strain of ameba also undoubtedly has considerable influence on initial colonization and continued tissue invasion. There is specific evidence based on experiments with human strains of *Endamoeba histolytica* in cats and dogs[38a, 62, 64] that different strains vary in their pathogenicity, but specific evidence is lacking in support of the view, predicated by Brumpt[65] and other European workers, that certain human strains of *E. histolytica* are nonpathogenic. An additional fact concerning this organism is significant, namely, that its virulence can be considerably enhanced by rapid passage through susceptible hosts.[38b, 62] This last property of the ameba may explain the rapidity with which an epidemic of amebic dysentery develops once heavy initial infection has been provided.

The factors thus far considered concerning opportunities for infection have been extrinsic in character and have not dealt with host susceptibility. Certain animals are undoubtedly completely resistant to infection with *Endamoeba histolytica*. In others, as the rat, there is suggestive evidence that colonization may possibly take place without the necessity of tissue invasion. On the other hand, in man, the monkey, the dog and the cat the evidence preponderates in favor of the view that infection can not be maintained for any length of time without tissue invasion. The kitten is a delicate test animal in amebiasis because it is highly susceptible to infection, the lesions develop rapidly and the infection is frequently fatal in a relatively short time. Monkeys are also readily infected with both human and simian strains of *Endamoeba histolytica,* but dysentery seldom results and typically only cysts are discharged in a semi-formed stool. In many respects the dog constitutes a particularly good laboratory animal for the study of amebiasis. If young dogs are properly conditioned for infection, at least 90 per cent. tissue invasion may be secured.[28, 31] In dogs the period of incubation can be shortened and the intensity of the infection can be increased by rapid passage of the organism from dog to dog.[62]

Thus, in the dog acute dysentery can be produced, comparable to that in the cat or to fulminating amebic dystentery in man. On the other hand, by appropriate technics the infection in the dog can frequently be transformed into a chronic state or at times terminated, even without the administration of specific anti-amebic drugs. Amebiasis in man varies both qualitatively and quantitatively. At times it resembles infection in the kitten; more frequently it simulates the infection in the dog; in the majority of cases, however, it is less severe and is comparable to simian infection.

Probably the most important single intrinsic factor which determines whether amebiasis in the susceptible animal is acute, chronic or relatively asymptomatic is the degree of host resistance based on the nutritional level. In general, carbohydrates provide an opportunity for *Endamoeba histolytica* to multiply, and animal proteins reduce this capacity,[66a, 66b, 67] but the problem is not so easily solved. In conditioning dogs for experimental infection with human strains of *E. histolytica* the writer found[19] that salmon and unfortified white bread provided a suitable low resistance diet for inducing and maintaining amebic infection, but that salmon alone was equally effective. Since these animals developed an anemia, it was important to discover if the cause was lack of the antianemic factor. Ventriculin exascerbated the condition, but fresh raw liver controlled it. Whole raw liver or freshly expressed juice of raw liver produced best results, providing amebostatic and at times amebicidal action.[28b] Moreover, fresh liver was much more effective than desiccated liver, while commercial liver extract or freshly extracted liver juice passed through a Seitz filter, when introduced parenterally, was ineffectual in controlling acute amebiasis, although both preparations stimulated erythropoiesis (Faust and Swartzwelder).[68] The most interesting finding in this series of experiments developed when finely ground-up fresh liver or fresh liver juice was employed as a high retention enema in dogs suffering from acute amebic colitis. The disease was as effectively controlled as when the fresh liver was fed to the animals.[28b]

Vitamins conceivably have a very important role in the control of amebiasis, but in so far as the writer knows this problem has not been subjected to critical experimental or clinical study.

An additional point in the evaluation of amebiasis in man concerns racial or group tolerance to the infection. There is no clear evidence indicating that race or sex is in itself important, but there are good epidemiologic data indicating that long exposure of a particular population group to strains of *Endamoeba histolytica* tends to establish a host-parasite equilib-

[64] W. W. Frye and H. E. Meleney, *Am. Jour. Hyg.*, 27: 580–589, 1938.

[65] E. Brumpt, *Trans. R. Soc. Trop. Med. and Hyg.*, 22: 101–114, 1928.

[66a] R. Hegner and L. Eskridge, *Am. Jour. Hyg.*, 21: 121–134, 1935; b. *Jour. Parasitol.*, 23: 105–106, 1937.

[67] D. R. Lincicome, *Am. Jour. Hyg.*, 36: 321–337, 1942.

[68] E. C. Faust and J. C. Swartzwelder, *Proc. Soc. Exp. Biol. and Med.*, 33: 514–518, 1936.

rium for the homologous strains of the parasite. In such groups of human beings, even with constant exposure due to primitive sanitary conditions and a correspondingly high rate of infection with a heavy "load" of parasites, clinical manifestations are uncommon.[20, 38a, 69] Nevertheless, individuals from outside the hyperendemic areas who are exposed to the same strains of *Endamoeba histolytica* not uncommonly develop a fulminating amebic colitis. It appears, therefore, that long-time constant exposure to amebiasis tends to produce considerable tolerance to the amebae, with consequent reduction in invasion and in destruction of tissue.

(To be concluded)

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ANTON JULIUS CARLSON

By Professor R. W. GERARD
UNIVERSITY OF CHICAGO, AND
Professor A. C. IVY
NORTHWESTERN UNIVERSITY

Time magazine, in its February 10, 1941, issue, placed the picture of Anton Julius Carlson on its cover and in the story called him "a Scientist's scientist." By popular vote of its 25,000 scientist members and by action of its council, the American Association for the Advancement of Science seems to have proven *Time's* assertion; for they have elected Dr. Carlson president of the association for 1944. Yet perhaps the designation is too narrow; Carlson is really the common man's scientist.

Few scientists of any period have been known so widely to the laity or have carried so variegated a load of civic, humanitarian and similar extra-curricular responsibilities. From the time of the last war, Carlson has progressively emerged from the confines of the laboratory to give freely of his time and effort and enthusiasm to serve the broad interests of science and education and to promote the intelligent application of these to human affairs. His skill as writer and speaker, his joy in a rough-and-tumble argument and his high scientific standing have placed him in great demand as lecturer, editor, adviser, legal expert, organizer, executive and plain fighter on "our" side—witness the joy of faculties all over the country when he, as president of the American Association of University Professors, was battling for them in "the den of deans."

Carlson's early boyhood was spent on the Swedish countryside. According to his own reminiscences, most of his time was devoted to herding goats. Surely the earthiness of the farmer was worn deeply into him: for to-day, after half a century in urban American life, there is little veneer over his directness of manner or simplicity of manners; just as he still says when excited, "It gives me the yim yams." Then followed a period as carpenter's apprentice in Chicago, which led to a denominational education at Augustana College and his placement as a minister in Montana. This phase also left its imprint, for Carlson's effectiveness as a teacher and protagonist is due as much to the evangelical zeal and revivalist's skill with which he presents his case as it is to the hard-headedness and logic of what he says.

Next came his long and passionate affair with science. It was love at first sight (of the writings of Jacques Loeb) and a stormy wooing and wedding. His first researches, one proving the neurogenic origin of the heart beat in Limulus and one showing a parallelism between the speed of action of a nerve and of the muscle it controls, were classics and soon brought him fame and his long-held position at the University of Chicago. Here, from 1904 to his retirement three years ago, he was first a member and then chairman of the department of physiology, teacher of a generation of scientists, a power on the campus and in national societies and an indefatigable worker. Here he, and his loyal colleague, Arno B. Luckhardt, performed studies on the stomach and hunger, on the whole digestive system, on the endocrines, on diet, on the lung, on all parts of the body.

Here he began his lecture schedule at seven in the morning and taught his daily way through classroom and laboratory until the mental scalps of his students were piled deep. He pulled no punches in his comments on their performance, and he was feared. But the kind heart below the rough tongue was also evident, and he was loved and followed.

World War I took Dr. Carlson (ending as Lieutenant-Colonel) to Europe and finally into Hoover's food rehabilitation group. The contact with starvation and other health problems, as well as the many intense experiences, launched Carlson into his next phase. He then threw himself into the national activities already mentioned. His recent commitments include, for example, the following: President of the Research Council on the Problems of Alcohol; the

Society for Experimental Biology and Medicine; the Union of American Biological Societies; the American Association of Scientific Workers, and the American Association of University Professors; Chairman or member of the editorial board of *Physiological Reviews;* the Board of Trustees, *Biological Abstracts;* the Committee to Promote Research on the Nature of Aging, National Research Council; the Public Advisory Committee, U. S. Public Health Service, and the Medical Advisory Committees of the National Foundation for Infantile Paralysis; Consultant to the U. S. Food and Drug Administration, and serving the Federal Trades Commission; the Office of War Information; the Aero-medical Service, and the Office of Price Administration.

But in whatever direction his bull-like energy and bull-dog determination are turned, whatever honors or obligations turn to him, Carlson remains the fearless, shrewd, self-reliant, feet-on-the-earth realist. Recently in Kansas, a mental telepathy enthusiast told how he suddenly felt at just nine o'clock one evening that his mother, in New York, needed him; and how he learned later that she had fallen down stairs that very evening at exactly nine o'clock. "And what," he said to Dr. Carlson, "do you think of that?" "My first thought," came the prompt response, "is of the hour difference between Eastern and Central time."

Dr. Carlson has long been known to his friends as Ajax. Every one thinks the nickname came from A. J.; but we know better. The name had to come, for was not Ajax the only heroic figure from the past who never called on man or God for aid, but always fought his own way out of trouble?

OBITUARY

EPHRAIM PORTER FELT
1868–1943

DR. E. PORTER FELT, widely known and respected in entomological circles for many years, died suddenly of a heart attack in his office at the Bartlett Tree Research Laboratories, Stamford, Conn., on December 14, 1943. Dr. Felt, the son of Charles Wilson Felt and Martha Seeth Ropes Felt, was born in Salem, Mass., on January 7, 1868. He graduated from the Massachusetts Agricultural College in 1891, and in 1892 and 1893 continued his studies at Cornell University under a fellowship, obtaining the degree of Sc.D. in 1894. During the years 1893 to 1895 he taught natural science at the Clinton Liberal Institute, Fort Plain, N. Y. In 1895 he was appointed assistant to Dr. J. A. Lintner, then state entomologist of New York, and following Lintner's death in 1898, he was made state entomologist, a position which he filled with distinction until his retirement in 1928. Following his retirement he became chief entomologist and director of the Bartlett Tree Research Laboratories, Stamford, Conn., where he continued his entomological work until his death.

As one of Professor John Henry Comstock's students at Cornell, Dr. Felt became one of the outstanding entomologists of the country. His annual reports of the state entomologist of New York are noteworthy entomological publications, and nearly every issue contains original contributions. Entomology was the center of Dr. Felt's life and activities. From 1898 to 1911 he was the entomological editor of the *Country Gentleman,* and when the *Journal of Economic Entomology* was started in 1908 he was its first editor, a position to which he was elected annually until his retirement in 1935, and in which he labored effectively for the good of entomology. Following the end of his active duties as editor he was elected honorary editor. In 1907 he was a member of the special commission for the study of the gipsy moth and brown-tail moth situations, inaugurated by A. H. Kirkland. The "Colcord Indexes to the Literature of American Economic Entomology," II to VI, were edited by Dr. Felt, the last one with the assistance of S. W. Bromley. In 1923 and 1924 he served as chief entomologist of the Gipsy Moth Bureau of the State Conservation Commission of New York, and for many years he was a member of the supervisory board of the American Yearbook Corporation. During the Pan-American Exposition at Buffalo, N. Y., in 1901, Dr. Felt was the honored recipient of one gold and three silver medals for his scientific contributions.

Dr. Felt was a fellow and an emeritus life member of the American Association for the Advancement of Science, a member of the Entomological Society of America, of which he was vice-president in 1916; the American Association of Economic Entomologists, of which he was president in 1902; and of its Eastern Branch; of the New York Entomological Society; of the Entomological Society of Washington and of the Cornell Chapter of the Society of the Sigma Xi. He was a constant attendant at meetings of national and regional entomological associations and shade tree bodies and gave freely of his time and knowledge to policy-making committees.

His scientific contributions run into hundreds of titles, many of them dealing with descriptions of new species of Itonididae. He was particularly interested in gall-producing insects, and his "Key to American Insect Galls" (N. Y. St. Mus. Bull. 200, 1918) and his later book "Plant Galls and Gall Makers" (Ithaca,

N. Y., 1940) are widely used. Many of his publications deal with insects injurious to trees, and all entomologists are familiar with his two-volume work entitled "Insects Affecting Park and Woodland Trees" (Mem. 8, N. Y. St. Museum, 1905–6), with its numerous excellent illustrations and colored plates. In 1924 the Macmillan Company brought out his "Manual of Tree and Shrub Insects." For many years he was interested in the dispersal of insects by air currents and published several papers on this subject. Although never wavering from his interest in entomology, during his last years he published extensively on the care of trees, as witnessed by his books on "Pruning Trees and Shrubs," "Our Shade Trees" and "Shelter Trees in War and Peace," all brought out by the Orange Judd Company as part of their Farm and Garden Library.

In addition to his life-long interest in gall insects and in shade tree insects, Dr. Felt was concerned with the major insect pests of the eastern United States, and always participated in conferences dealing with their control. In addition he was a frequent speaker at entomological gatherings and before groups interested in the care of trees. His entomological interests were varied and his writings, both scientific and popular, were always thoughtful and sound. During his busy and complete life he contributed extensively to the advancement of entomology in this country. Always affable and willng to share his information, Dr. Felt was liked and admired by every one and the familiar figure of this slender, scholarly gentleman will be missed at many future entomological gatherings. The paths of many scientific workers are made easier by the industry of a few, and Dr. Felt was one of the few. Dr. Felt was married in 1896 to Helen Maria Otterson, who died in 1939. He is survived by a son and three daughters.

H. B. WEISS

RECENT DEATHS

DR. THOMAS SCOTT FISKE, emeritus professor of mathematics at Columbia University and for thirty-five years secretary of the College Entrance Examination Board, from which he retired in 1936, died on January 10. He was seventy-eight years old.

RAY T. STULL, chief of the heavy clay section of the National Bureau of Standards, died on January 5 at the age of sixty-eight years.

DR. JOHN CARL BELTZ, research chemist of the U. S. Bureau of Mines, Washington, D. C., died on January 10 at the age of forty-seven years.

DR. BENJAMIN WESLEY KILGORE, state chemist of North Carolina, died on January 3 in his seventy-seventh year. He was formerly director of the North Carolina Agricultural Experiment Station and of the Extension Service and dean of the College of Agriculture of the North Carolina State College.

DR. JOHN S. FONDA, assistant director of sales of the Grasselli chemicals department of E. I. du Pont de Nemours and Company, died on December 22. He was forty-six years old.

DR. WILLIAM P. FRASER, emeritus professor of biology of the University of Saskatchewan, formerly chief of the Dominion Laboratory of Plant Pathology at Saskatoon, died on November 23 at the age of seventy-six years.

SCIENTIFIC EVENTS

SURVEY OF THE AMERICAN FORESTRY ASSOCIATION

AN appraisal has been initiated by the American Forestry Association of the effect of the war on the forest resources of the country so that post-war reconstruction and problems of forest management and land economy may be dealt with on a factual basis. The survey has the support and cooperation of state and federal forestry agencies and the forest industries. It will be completed, it is estimated, in from two to three years. John B. Woods, of Portland, Oregon, an authority on timber valuation, formerly forester for the Lumber Code Authority under the National Industrial Recovery Act, will direct the survey. He will be at the head of a staff of well-known specialists in forest appraisal and will be assisted by an advisory council of five members prominent in state and federal forestry, forest industry and in agriculture.

Members of this council are: William G. Howard, of Albany, New York, director of Lands and Forests, New York State Conservation Department; James W. Girard, of Washington, D. C., Division of Forest Economics, U. S. Forest Service; William B. Greeley, of Seattle, Wash., a former chief forester of the United States, now secretary-manager of the West Coast Lumbermen's Association; S. T. Dana, dean of the School of Forestry and Conservation of the University of Michigan and editor of the *Journal of Forestry;* and E. O. Siecke, Wisner, Nebr., farmer and veteran forestry leader in Texas and the South.

The main objective of the appraisal is to provide information for the handling of local, state and national postwar forest and land-use problems. According to Ovid Butler, executive secretary of the association, a forest appraisal consultant will be appointed in each of the principal forest regions of the country. With a state as a study unit, they will inventory forest

land conditions and appraise the effects of war on the forests. Assurances of active cooperation have been given by state forestry departments and other state, regional and federal agencies. Lines of study to be followed include recapitulation of forest and farm woodland surveys—inventory of timber-growing stock and forest lands; ownership and management of forests by federal, state and private classifications—land, timber and other forest values; extent and character of forest drain since 1940; utilization trends, with particular attention to wartime uses and peacetime possibilities; marketing of forest crops; public attitudes toward forest resources and industries; permissible postwar drain—silvicultural, quality and other economic factors; scope and effectiveness of forest legislation with reference to protection, perpetuation and utilization of forest resources; and ownership problems and trends—local and federal taxes.

THE TORREY BOTANICAL CLUB

DR. CHARLES THOM, of the Bureau of Plant Industry, U. S. Department of Agriculture, spoke on December 7 before the Torrey Botanical Club. His subject was "A Mycologist Looks at Antibiotics, especially Penicillin." A hundred and fifty members and guests gathered at Columbia University to hear his address.

The annual meeting and banquet were held at the Men's Faculty Club of Columbia University on January 4. Colonel Arthur F. Fischer, known for his flight from the Philippines with several million seeds of high-yielding quinine plants, gave the address. Colonel Fischer was introduced by the retiring president, Dr. William J. Robbins. The following officers were elected to serve in 1944:

President, Dr. Michael Levine, Montefiore Hospital.

1st Vice-president, Dr. Fred J. Seaver, New York Botanical Garden.

2nd Vice-president, Dr. H. K. Svenson, Brooklyn Botanic Garden.

Corresponding Secretary, Dr. Edwin B. Matzke, Columbia University.

Recording Secretary, Miss Honor Hollinghurst, New York City.

Treasurer, Mrs. John S. Karling, New York City.

Editor, Dr. Harold W. Rickett, New York Botanical Garden.

Bibliographer, Mrs. Lazella Schwarten, New York Botanical Garden.

Business Manager, Dr. H. H. Clum, Hunter College.

Members of the Council: Dr. Lela V. Barton, Boyce Thompson Institute; Dr. E. H. Fulling, New York Botanical Garden; Dr. J. S. Karling, Columbia University; Rutherford Platt, New York City.

Delegate to New York Academy of Sciences, Dr. B. O. Dodge, New York Botanical Garden.

Representative on Board of New York Botanical Garden, Dr. H. A. Gleason, New York Botanical Garden.

Representatives on the Council of the American Association for the Advancement of Science: Dr. J. H. Barnhart, New York Botanical Garden; Dr. A. F. Blakeslee, Smith College.

LECTURES ON MEDICAL EDUCATION

A SERIES of six lecture discussions on "The Relation of Medical Education to the Practice of Medicine of the Future" are being held at the New York University College of Medicine on successive Monday evenings at 5 P.M. The first lecture was given on January 17. Representatives of medical foundations, medical and liberal arts colleges, public health services and professional committees are taking part.

Dr. Alan Gregg, medical director of the Rockefeller Foundation, opened the series with a paper entitled "Looking to the Future." Discussion was led by Dr. Walter B. Cannon, of Harvard University, who was recently appointed visiting professor at the New York University College of Medicine, and Dean Willard C. Rappleye, dean of the College of Physicians and Surgeons of Columbia University.

Lecturers at future meetings will include Dr. Leonard Carmichael, president of Tufts College; Dr. Joseph W. Mountain, assistant surgeon general, U. S. Public Health Service; Dr. Louis Hamman, associate professor of medicine of the School of Medicine of the Johns Hopkins University; Dr. Franz Goldman, associate clinical professor of public health of the School of Medicine of Yale University; and Dr. A. D. Macdonald, dean of the Medical School of the University of Manchester, England.

Discussion leaders will include Dr. Elmer J. Butler, professor of biology, Princeton University; Dr. Harry S. Mustard, director, DeLamar Institute of Public Health; Dr. Michael M. Davis, chairman, Committee on Research in Medical Economics; Dr. Jean A. Curran, president and dean of the Long Island College of Medicine, and Dr. Homer W. Smith, Dr. Henry E. Meleney, Dr. William S. Tillett, Dr. S. Bernard Wortis, Dr. Evan W. Thomas and Dr. R. Keith Cannan, all of the faculty of the New York University College of Medicine.

The sessions will be presided over by Dr. Harry Woodburn Chase, chancellor of the university.

GRANTS-IN-AID OF THE PERMANENT SCIENCE FUND OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

INCOME from the Permanent Science Fund, by agreement and declaration of trust, is disbursed by the American Academy of Arts and Sciences in support of "scientific research in the fields of mathematics, physics, chemistry, astronomy, geology, geography, zoology, botany, anthropology, psychology, sociology and economics, history and philology, engi-

neering, medicine, surgery, agriculture, manufacture and commerce, education or any other science of any nature or description."

Applications for grants-in-aid are receivable on forms which will be supplied upon request by the chairman of the committee, and will be considered by the committee of award on March 1, June 1 and October 1.

It is stipulated that title to equipment purchased outright from a grant from the Permanent Science Fund resides in the fund, such purchased equipment being subject to reassignment by the committee upon termination of research in the particular field of endeavor in support of which a grant is made.

It is further a condition of grants made by the academy from the Permanent Science Fund that they are not for financial support of work the results of which comprise partial fulfillment of requirements for an academic degree.

It is a policy of the committee not to approve requests for general permanent equipment for institutions.

Communications should be addressed to John W. M. Bunker, *Chairman,* Permanent Science Fund Committee, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

THE COMMONWEALTH FUND AND MEDICAL RESEARCH

ACCORDING to the official summary of the twenty-fifth annual report of the Commonwealth Fund for the year ending September 30, 1943, the fund has contributed directly to undergraduate and graduate teaching in medicine by subsidizing departments of preventive medicine and psychiatry at medical schools, by offering advanced fellowships to instructors chosen by their department heads as potential leaders in medical education and by financing interschool visits by outstanding medical teachers. It has just begun a six-year schedule of grants to the Long Island College of Medicine for the development of its department of psychiatry.

Medical research has taken more and more of the fund's income. Of the $4,000,000 appropriated for this purpose in 25 years, nearly a tenth was distributed in the fiscal year ended October 30, 1943, when aid was given to 41 investigations at 11 university schools of medicine and 8 other institutions of similar scientific standing. War medicine plays a large part in current research. Studies of kidney and respiratory function, long aided by the fund because of their physiological importance, have made important contributions to the understanding of shock, now a crucial military problem, and grants have been made specifically for work of military significance in aviation medicine and the control of infectious disease. The three grants made this year for work not previously supported included one to the University of Pennsylvania, for a study by Dr. Max B. Lurie of physiological factors responsible for differences in susceptibility to tuberculosis; one to Washington University, for a study by Dr. W. Barry Wood, Jr., of recovery factors in certain types of pneumonia; and one to the New Jersey Agricultural Experiment Station for Dr. Selman A. Waksman's investigation of new substances derived from molds or fungi which, like penicillin, might be useful in the control of disease agents.

For the past two years fellowships have been offered to Latin-American physicians and public health workers for postgraduate study in the United States. Under this plan three men from the Argentine Republic, two each from Brazil, Uruguay and Venezuela, and one each from Chile, Colombia, the Dominican Republic, Ecuador, Haiti and Honduras hold appointments for the current academic year. Awards are made with the cooperation of the Pan American Sanitary Bureau. According to the report, these Latin-American fellows "are well-trained, energetic, eager to improve themselves, and almost without exception are either holding or preparing to hold positions of responsibility in public health and clinical medicine."

SCIENTIFIC NOTES AND NEWS

THE Charles P. Daly Medal of the American Geographical Society of New York has been awarded to Sir Halford John Mackinder, the English geographer and statesman, and the Cullum Geographical Medal to Arthur Robert Hinks, secretary of the Royal Geographical Society, London. Presentation of the medals will be made in London later in the winter. Sir Halford served as reader in and professor of geography at the University of London from 1900 to 1925 and as member of Parliament and chairman of the Imperial Economic Committee from 1926 to 1931. Mr. Hinks has been secretary of the Royal Geographical Society since 1915. Honorary corresponding memberships in the society have been awarded to Dr. Christovam Leite de Castro, secretary-general of the National Council of Geography of the Brazilian Institute of Geography and Statistics, and to Señor Manuel Medina, chief of the Geographical Office of the Ministry of Agriculture and Development of Mexico.

WILLIAM H. MCAVOY, chief test pilot of the National Advisory Committee for Aeronautics, has been

chosen as the recipient of the Octave Chanute Award for 1943 of the Institute of Aeronautical Sciences, in recognition of "continuous service in the flight-testing of experimental airplanes under hazardous conditions imposed in aeronautical research." The presentation will be made on January 24 at the honors night dinner of the institute at the Hotel Waldorf-Astoria.

THE Bailey K. Ashford Award was presented at the Cincinnati meeting of the American Society of Tropical Medicine to Norman H. Topping, passed assistant surgeon of the U. S. Public Health Service, National Institute of Health, Bethesda, Md., in recognition of his "outstanding work in the field of tropical medicine." In 1941 he went to La Paz, Bolivia, to study the effects of a typhus vaccine developed at the Rocky Mountain laboratory of the U. S. Public Health Service at Hamilton, Mont.

ERNEST B. BABCOCK, professor of genetics at the University of California at Berkeley, and Dr. William H. Chandler, professor of horticulture at the University of California at Los Angeles, have been named faculty research lecturers for 1944. They will lecture on the subject of their researches during charter week from March 19 to 25.

A HUNDRED and twenty letters from professional associates and friends from all over the country were bound and presented on December 20 to Dr. Oswald Schreiner, at a meeting in his honor at the station of the Bureau of Plant Industry of the U. S. Department of Agriculture at Beltsville, Md. Dr. Schreiner, who joined the Bureau of Soils in 1903 and became later chief of investigations in soil fertility, retired on December 31 after serving for forty years.

THE award of the League of Fraternal and Benevolent Organizations of the Jewish Education Committee of New York was made at a luncheon given on January 9 to Dr. Arthur H. Compton, professor of physics at the University of Chicago, for his "effective promotion of justice, amity, understanding and cooperation among the peoples of all creeds in our beloved land and in other lands." Dr. Compton, who was unable to be present at the luncheon, sent a telegram accepting the award.

THE University of Delaware recently conferred upon Thomas Hamilton Chilton, of the E. I. du Pont de Nemours and Company, the honorary degree of doctor of science in recognition of "his distinguished achievements in the province of chemical engineering and his invaluable personal contribution to the welfare of that institution."

RESULTS of the election of officers of the Genetics Society of America for the year 1944, carried out by postal-card ballot in the absence of an annual meeting, are announced as follows: *President,* Professor A. H. Sturtevant, California Institute of Technology; *Vice-president,* Dr. B. P. Kaufmann, Carnegie Institution, Cold Spring Harbor; *Secretary-treasurer* (for a term of three years), Professor L. H. Snyder, the Ohio State University. The executive committee of the society for 1944 will include Professors E. W. Lindstrom, the Iowa State College, and M. M. Rhoades, Columbia University, presidents in 1942 and 1943.

THE officers for 1944 of the American Society for Horticultural Science are: *President,* Dr. Warren P. Tufts, University of California, Davis; *Vice-president,* Dr. Warren B. Mack, Pennsylvania State College, and *Secretary-Treasurer,* Dr. H. B. Tukey, Experiment Station, Geneva, N. Y.

DR. WALTER B. CANNON, emeritus professor of physiology at Harvard University, has been elected president of the newly founded American-Soviet Medical Society. Dr. Henry E. Sigerist, director of the Institute of the History of Medicine, the Johns Hopkins University, has been appointed editor of its journal, *The American Review of Soviet Medicine.*

OFFICERS elected for 1944 by the American Association of Textile Technologists are Lieutenant William F. Macia, *President;* Carl I. Taber, *First Vice-president;* Pierre Sillan, *Second Vice-president;* Ralph Gutekunst, *Treasurer,* and Bernice S. Bronner, *Secretary.*

DR. FERDINAND J. M. SICHEL has been promoted to an associate professorship of physiology at the College of Medicine of the University of Vermont.

DR. R. MENDEZ, instructor in pharmacotherapy at the Harvard Medical School, has been appointed assistant professor of pharmacology at the Loyola University School of Medicine, Chicago. He will assist Dr. A. S. Marrozzi, who is chairman of the department of pharmacology.

DR. J. A. SHELLENBERGER has resigned his position as technical adviser to the Corporacion para la Promocion del Intercambio, S. A., at Buenos Aires, which is sponsored by the Government of Argentina, to accept an appointment as professor of milling industry at the Kansas State College. He expects to return to this country late in February.

Nature reports that the title of professor of technical optics in the University of London has been conferred on Dr. L. C. Martin in respect of the post held by him at the Imperial College of Science and Technology.

GEORGE I. QUIMBY, JR., assistant curator of North American ethnology at the Chicago Natural History

Museum, has been promoted to be curator of exhibits in the department of anthropology.

J. VICTOR SKIFF has been appointed to the post of Deputy Conservation Commissioner of New York State to succeed John L. Halpin, who is resigning from the department as of January 31.

R. A. BOYER, of the Ford Laboratory at Dearborn, Mich., has become director of scientific research with The Drackett Company, Cincinnati, Ohio. He is continuing his work on soybean fiber.

BASIL A. PLUSNIN has been appointed forester of the 8,000-acre forest of Yale University in Tolland and Windham Counties, Connecticut.

PROFESSOR ORA S. DUFFENDACK, since 1922 a member of the faculty of the University of Michigan, has resigned to accept a position in private industry with the North American Philips Company of New York City. He will organize and direct a new research staff and laboratory for which he will be given a free hand in selecting both research fields and staff members. He will sit in on the board of directors of the company. For the past two years he has been chief of a research section of the National Defense Research Committee in the Randall Physics Laboratory of the university. He expects to continue to supervise this work.

DR. CARL L. A. SCHMIDT, dean of the College of Pharmacy of the University of California, has leave of absence for the last half of the present academic year to enable him to complete researches in biochemistry in which he is engaged. Dr. Troy C. Daniels, assistant dean and professor of pharmaceutical chemistry, has been appointed acting dean.

DR. LEO L. CARRICK, dean of the School of Chemical Technology, North Dakota Agricultural College, has been appointed consulting chemical engineer and director of the research on red lead being carried out by the Lead Industries Association of New York City.

DR. OSCAR NEUMANN, formerly ornithologist of the Berlin Museum, said to have been one of the last Jewish refugees to be able to escape from Germany, is now working at the Chicago Natural History Museum.

DR. WILLIAM DUNCAN STRONG, professor of anthropology at Columbia University and director of the Ethnographic Board of the Smithsonian Institution, gave an address on January 20 before the Washington Academy of Sciences entitled "Recent Anthropological Research in Latin America." This was the forty-sixth annual meeting of the academy.

IT is announced that the American Medical Association will hold its annual meeting from June 12 to 16 in Chicago. The House of Delegates will meet in the Palmer House, where the scientific exhibit and the opening general meeting will also be held. The registration bureau and the technical exhibits will be in the Hotel Stevens, and the meetings of the various sections will be assigned to these hotels and in addition to the Hotel Sherman and the Morrison Hotel.

AN appraisal of the estate of Edward S. Harkness, who died in 1940, shows that he left $54,000,000 more to be divided among educational, charitable and religious organizations, some of which he helped to establish. He had given away in his lifetime more than $120,000,000. Mr. Harkness left his residuary estate in trust for the benefit of his widow, Mary Stillman Harkness. Upon her death the charities will share the principal of her trust. One half will go to the Commonwealth Fund, a foundation established in 1918 by Mrs. Stephen S. Harkness.

ACCORDING to the will of Edgar Palmer, who died last January, Palmer Square, now three-quarters completed, which consists of the Princeton Inn, a theater and several other buildings, is bequeathed to Princeton University. He also gave a laboratory valued at $750,000 in addition to the $1,000,000 Palmer Stadium. His will carries a provision that should his daughter die leaving no children, $1,000,000 of the $2,000,000 left in trust for her should go to the trustees of the university.

ALBERT H. SCHMIDT, of Detroit, has given to the Board of Education of Wayne University the sum of $10,000 to assist in establishing an agricultural school at a farm now owned by the board near Novi, Mich., to be known as the Albert H. Schmidt Foundation. The project is to be developed and conducted by Wayne University. He has indicated that it is his intention ultimately to leave substantially his entire estate to further the project. In addition to providing educational opportunities for boys from 14 to 18 years of age, the school will provide a research center in the natural and physical sciences related to the development of agriculture. Although the new institution will be supported in part by revenues derived from the students, it is expected that a major part of its income will be obtained from the sale of farm produce, from funds to be provided by Mr. Schmidt and from other resources which the Board of Education may use for the development of the school. It is anticipated that the produce of the farm will be used in the cafeterias of the Detroit Public Schools.

THE late Dr. Russell Henry Chittenden, formerly professor of physiological chemistry and director of the Sheffield Scientific School of Yale University, bequeathed his scientific library to the university and a trust fund of $3,000, the income of which is to be used for a prize to be known as the Russell H. Chittenden Prize, to be awarded at commencement to the

member of the graduating class who stands highest in his class at the Sheffield Scientific School.

GIFTS to Columbia University, aggregating $44,770, have been announced, to be used largely to finance research in medicine, chemistry and allied sciences and to support work in other fields. The larger gifts include $24,200 from the John and Mary R. Markle Foundation in support of a study of the chemotherapy of filariasis; $5,000 from the Lederle Laboratories, Inc., to be credited to the Bell gift for enzyme chemistry in the department of medicine, and $4,000 for dietary research from Swift and Company.

Chemical and Engineering News reports that the Howes Publishing Company has endowed an Olney Medal to be awarded by the American Association of Textile Chemists and Colorists "to afford public recognition of outstanding achievement in the field of textile chemistry" and as a testimonial to Louis Atwell Olney, president emeritus of the association and chairman of its research committee, in recognition of his lifetime of devotion and contributions to this field. The candidate receiving the award will be selected by a committee of five members of the association.

THE Library of the U. S. Department of Agriculture is now issuing a monthly Bibliography of Agriculture, which will organize all the information in current agricultural literature, regardless of the form of the publication or the language in which it was originally published. The number of titles listed each year is expected to exceed 50,000.

THE first issue of the *British Journal of Industrial Medicine* is to be published in January, 1944, under the editorship of Dr. Donald Hunter. It will appear quarterly. Its headquarters are at the British Medical Association House, Tavistock Square, London, W.C. 1. Editorial communications should be sent to Dr. Hunter at the London Hospital.

THROUGH Dr. John D. Long, of the Pan American Sanitary Bureau of Washington, who recently visited Uruguay, the Government of the United States has offered a donation of $500,000 to Uruguay for improvements in public health. Uruguay will contribute an additional fund of $100,000 for the same purpose. The work will be carried on by American and Uruguayan specialized technicians.

DISCUSSION

VITAMER OR ISOTEL? BOTH?

IN the issue of SCIENCE for October 29, Dr. Roger J. Williams criticized the choice of the word "vitamer" to "designate vitamin forms that can replace one another."

Rather, I believe, the word vitamer was coined to represent just what its root words mean, life-part, that part of the diet of any animal that performs the same function, regardless of the fact that quite different chemical entities may be required in different species to perform this specific effect that the vitamer under discussion is characterized for.

That is a separate purpose than that for which Dr. Williams suggests the term "isotel." An isotelic vitamin or food factor would be, according to his definition, a factor that can replace another in a given diet or nutrient media, for some specified species, or under a given set of circumstances. Evidently, we are in need of both terms to accurately express ourselves in dealing with the situation we are confronted with.

Vitamer A, accordingly, is that factor in any nutrient system that provides the vitamin A effect. It may be carotene for one species, kryptoxanthin for another, vitamin A_1 in salt water fish, vitamin A_2 for fresh. But for the human species, carotene is isotelic with vitamin A, for carotene can be converted into vitamin A in the human, thus can replace it in the diet of this specific species. Carotene, for the human species, therefore, would be isotelic with vitamin A. In the case of the cat, however, which can not make this conversion, carotene is not isotelic with vitamin A. A list of the vitamin A isotels for the cat would not include this factor.

The A vitamers for the cat are the isotelic substances that afford the nutritive effect of vitamin A for the cat. If the cat can only make use of one substance, there are then no vitamin A isotels for the species, but there always would be a vitamer A for any species that requires that vitamin in any form.

The term vitamer is just as hypothetical as the term carbohydrate or protein. A carbohydrate is that portion of the diet that supplies energy. It may be starch for the human, cellulose for the rabbit. Cellulose is not isotelic with starch for the human organism, but it is for rabbits and ruminants.

As cobalt and manganese are isotelic in their effect of activating enzymes, this term may be found representative for probably all classes of food factors, whether simple or complex. Vitamers, however, seem to be representative of the more complex food factors. Such of the vitamins as are found conjugated with proteins in foods seem to be relatively specific for species. The pellagra preventive vitamer is a good example.

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CLARASE INACTIVATION OF PENICILLIN

DR. C. A. LAWRENCE reported in SCIENCE (98, 413, 1943) that penicillin could be inactivated by clarase (standardized) as a preliminary step toward the sterility test for penicillin. The writer had been unsuccessfully attempting to do the same thing with a sample of clarase (standardized), when the above-mentioned report was published. Two samples of clarase (regular) and one of clarase (standardized) were secured and, together with some regular clarase already in the laboratory, comparative tests were made.

The 4 per cent. solution of clarase was made in a buffer of pH 5.2 and passed through Seitz filters to sterilize it. This was then tubed aseptically and stored in the refrigerator. The sodium salt of penicillin was dissolved in sterile distilled water to give approximately 20,000 units per milliliter. Two milliliters of this penicillin solution were then mixed with 2 ml of the 4 per cent. clarase solution being tested and placed in a waterbath at 40° C.

This experiment was repeated three times with different lots of penicillin, and the same results were obtained each time. Out of five samples tested, only one (regular clarase No. 1351) completely inactivated 9,000 units of penicillin in six hours but not in four. A sample of the same batch (No. 1351) subsequently received reduced the titer from 10,000 units to approximately 200 units in six hours. The other samples (regular clarase No. 1466, standardized clarase No. 1339, standardized clarase No. 1104 and an unnumbered batch of regular clarase) were essentially inactive, giving no appreciable inactivation of penicillin in 24 hours. All samples of clarase were secured from Takamine Laboratory, Inc., Clifton, N. J.

If clarase is to be used for the inactivation of penicillin prior to the sterility test, each lot must be tested and certified for this particular activity.

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CENTRALIZATION OF PERSONAL RECORDS

ALTHOUGH the nation periodically surveys its industry, commerce and agriculture, and once each decade tabulates its population, it is only in time of war that an exhaustive inquiry is made into its human resources. Even in time of war, the group examined constitutes only a small percentage of the total population.

Many physicians, psychologists, biometricians and physiologists long have felt the need for the centralization of medical and other personal records. Such records would be held in strictest confidence, and would be available only to licensed physicians, authorized public agencies and those qualified in scientific research.

Special forms might be designed for the recording of data. The analysis of such forms would bring under scientific scrutiny the life careers of 135,000,000 human guinea pigs. The data collected would include the complete medical history of the individual from birth to date. His medical record would follow him wherever he went, and would be made available to the physician of his choice. Every physician would be asked or required to file periodic reports on his patients. The assembled records might also include fingerprints, intelligence ratings, family history, education, work history, special skills, hobbies and other pertinent information. Such a project would provide us with invaluable material concerning the nation's most precious resource, namely, human beings.

Material gathered in the course of the war well might serve as a nucleus for such a collection of data. The records would be retained permanently, perhaps for generations, and would be assembled at strategic locations throughout the country. Such records should exist for the entire population.

At the present time, although a tremendous fund of health and other personal data exists, it is not being fully utilized. Much of it is being destroyed by schools, physicians and by the individual himself. The material which survives is often so scattered and so deeply buried that it is of no practical value. Some of the benefits which would derive from the adoption of the proposed plan include:

(1) It would improve medical treatment and facilitate diagnosis. Individuals often change their physicians, either because of choice or necessity, and hence there is no continuity in the medical history. It is well known that patients frequently are unable to provide their doctors with accurate case histories. This is an important handicap in medical practice.

Knowledge of the course of a disease has much to do with its proper management. Complete records would eliminate unnecessary duplication and would bring to light conditions which the busy physician could not determine without a great deal of work. Such records would definitely improve the quality of medical practice and would save time and money.

(2) It would make available to public health agencies a source of important leads with regard to public health work. It would improve our control of communicable disease. It would give us the most accurate picture of the public health and of public health needs that we ever have had.

(3) It would contribute to the national security and to our military effort, by showing us the availability of our human resources for uniformed or indus-

trial duty or for other activities in the national interest. It would do for the nation what the National Roster of Scientific and Specialized Personnel has done for some of the professions. It would enable us to plan our educational program more intelligently, and to correct remediable health defects in those who must be the backbone of any military effort we may be called upon to make.

(4) It would provide an almost limitless source for research in genetics, longevity, disease, human behavior and a hundred other fields. From the systematic study of such data would come leads and discoveries of tremendous value to science, and, ultimately, of tremendous benefit to the individual. Such a reservoir of data would have a thousand and one uses, many of which we to-day can not even foresee.

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EDITORIAL CHANGES IN SCIENTIFIC PAPERS

DR. WILLIAM C. BOYD (SCIENCE, August 27, 1943) complains of editorial changes whereby a substantive modifying a noun (in his manuscript) becomes an adjective modifying a noun (on the printed page).

Probably the most important factor in the impairment of English speech to-day is the fallacy that parts of speech may be connected without the use of connectives. Without knowing what journals are under criticism, it may be safely conjectured that the editors have, as a safeguard, wisely established a style which will permit this malady (a noun modifying a noun) to be treated both in its early and in its acute stages, where (with apologies to Gert. Stein) a noun modifies a noun modifies a noun modifies a noun. More rigorous and more intelligent editing would have prevented the following expressions, all of which recently appeared in print: "rudder control mechanism sequence," "material control shortage group," and "instrument approach procedure summary."

The first cited instance of Dr. Boyd's displeasure is the editorial change of "horse serum" (which is ambiguous) to "equine serum" (which is unmistakably clear). "Horse serum" may mean serum *for* the horse, serum *from* the horse, or serum *of* the horse, just as the widely used expression "Consumer research" may mean research *by* the consumer, research *concerning* the consumer, or research *for* the consumer. The argument that the man who elects to read any material will understand which one is meant is not a valid one. How do we know? Surely one of the most important functions of language is to convey information to the uninformed, and the language of science should be written not only so that it can be understood, but so that it *can not be misunderstood.* In attaining this end, proper editing will continue to be of great value.

E. H. MCCLELLAND

CARNEGIE LIBRARY OF PITTSBURGH

SCIENTIFIC BOOKS

RADIO AND ELECTRONICS

Experimental Electronics. By RALPH H. MILLER, R. L. GARMAN and M. E. DROZ. New York: Prentice-Hall, 1942.

Principles of Radio. By KEITH HENNEY. 4th Edition. New York: John Wiley and Sons, 1942.

Principles of Electronics. By ROYCE G. KLOEFFLER. New York: John Wiley and Sons, 1942.

Elements of Radio. By ABRAHAM MARCUS and WILLIAM MARCUS under the editorship of RALPH E. HORTON. New York: Prentice-Hall, 1943. $4.00.

Fundamentals of Electricity. By LESTER R. WILLIARD. New York: Ginn and Company, 1943.

RADIO and electronics have permeated every branch of our war effort. The production of electronic equipment for the armed forces alone is several times the normal peace-time production. The dissemination of war information makes the maintenance of home radio receivers and the broadcast stations an industry essential to the prosecution of the war. In addition, war industries, from gasoline refineries to ordnance manufacturers, have found this new tool, electronics, so valuable in reducing man hours that the development and manufacture of such apparatus is being carried on under the highest priorities. The vacuum tube is no longer only the bulb in the parlor radio. It has gone to war. We find it by the guns and in the factory.

People from many walks of life are finding that they must learn of the electron tube and its applications. The chemical engineer finds it controlling his processes. The power plant engineer finds it increasing the efficiency of his boilers. The foreman of the manufacturing plant finds it used as a tool on his production line. The airplane manufacturer finds it molding his fuselage and wing parts. The shipbuilder finds it in his welding operations. The ordnance officer finds it throughout his equipment. The naval officer and the air force officer would be lost if it failed.

These applications of the electron tube have shown the need for personnel trained in the field of radio and electronics. The present scarcity of trained personnel is requiring the employment of many persons who are unfamiliar with even the basic principles

of electronic circuits. Many in positions of responsibility are finding that they must dig in and learn something of this field if they are to avoid being surpassed by progressive youngsters.

Training in this subject is different from mathematics or any such standard subject. Except for a negligible number of specialists, it has been omitted from the training of all who now need it, from the Ph.D.'s training as well as from the high-school course. However, the individual with a mathematical and scientific training may be expected to learn the subject in an entirely different manner from that adopted by the high-school boy. The electrical engineer would be in a different class from the naval architect. The trainee who is to become an electronic design specialist should approach the study in a different manner than the trainee who needs a brief course to learn to maintain a particular type of equipment or the trainee who needs a survey course to determine possibilities of electronics in a new field.

The books included in the above group are five of the many recent books on radio and electronics, each intended to train persons who have a particular type of background to fill some position among the varied electronic applications or to start along the road toward a thorough training in the field. Because of the varied character of the training needed, none of these books compete directly with each other. They each have their own special zone of application.

"Fundamentals of Electricity," by Williard, is written for use in training in high school. Upon finishing this course together with the courses regularly taken by the high-school student, the trainee will have a background upon which he can build a thorough training in any of the many branches of electricity. It fits nicely as the first course in electricity for the boy who will continue in one of the several vocational training courses in electricity. Its use as a basic pre-induction training for the several technician ratings in the Army is quite natural. The specialized training given to these men in the Army itself is far more satisfactory when it is preceded by a general course in the basic fundamentals of electricity.

"Elements of Radio," by Abraham Marcus and William Marcus, is written specifically for the person with an avid interest in learning about radio. In this book each section is started by posing a question such as that asked by the beginner in radio or describing a phenomenon with which the student is undoubtedly familiar. Then follows the process of leading his thoughts, bringing him up against a barrier which he can cross only by learning the fundamentals of electricity. This process may be expected to fan the waning interest of the bored student, causing him to continue with his study. The book is to be recommended to those who start studies enthusiastically but fail to continue when the study approaches drudgery.

"Principles of Radio," by Henney, is in its fourth edition in a little over a decade. That shows definitely that it has been well received. This book has been very popular as the text in vocational training in radio. It is very good in this field and is to be recommended for the radio student who has recently studied his high-school algebra and trigonometry. It is necessary for the student to have a working knowledge of algebra. With this background the student using this book gets a far more thorough understanding of radio than with either of the two preceding books. The student after completing one of the above books might well continue his studies with this as a text.

"Principles of Electronics," by Kloeffler, leaves the subject of radio to other texts, presenting the general principles and devices involving the flow of electricity through mediums other than solids. Various devices involving such flow together with circuits using these devices are discussed. The uses of electronics are covered very briefly. For instance, radio receivers and transmitters are treated in four and a half pages. The book is definitely designed for engineers. While it is written for an introductory survey course in electronics for prospective students of electrical engineering, it seems best adapted for the graduate engineer who completed his studies before electronics was introduced into the curriculum and now finds that subject necessary. It may be criticized for being too condensed even as a short survey. Where the subject must be condensed to this extent, this book fits the bill admirably.

"Experimental Electronics," by Muller, Garman and Droz, is written specifically for research workers who find electronics necessary as a laboratory tool. The book is a laboratory manual for use in an extensive laboratory course. Such a course is an ideal training for the scientific experimentalist. However, the book's usefulness is not limited to the role of accompaniment with many hours spent in the electronics laboratory. The experiments are discussed and described so adequately and the sample results are set forth so completely that experimenters experienced in reviewing reports of laboratory work hardly need to see the experiment performed in the laboratory to fully visualize the apparatus and its operation. The book may be advantageously used by such workers, even though they intend to carry out very few or even none of the experiments specified. It should be strongly recommended for the research worker who expects or hopes to use electronic devices in his laboratory.

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SPECIAL ARTICLES

ABSENCE OF AUDIOGENIC SEIZURES IN WILD NORWAY AND ALEXANDRINE RATS[1]

NUMEROUS observers[2, 3] have reported that loud sounds of high frequency have a profound effect on the behavior of rats. They produce in the rats a high state of excitement characterized by wild undirected running and culminating in a convulsive seizure. In all instances the rats were of the common Norwegian variety which have been bred and raised under laboratory conditions for many generations. It occurred to us to determine whether wild rats taken directly from their native haunts would also show these convulsive seizures when exposed to loud sounds of high frequency.

Opportunity to make these observations came incidentally to other studies on a large number of wild Norway and Alexandrine rats which were trapped alive in alleys, cellars, yards, factories and granaries. Essentially the same technique of auditory stimulation was employed as in previous experiments on the production of convulsive seizures in the domesticated rat. Air-blast, key jingling and air-driven Galton whistle served as stimuli. One hundred and twenty-six wild Norway rats and fifteen wild Alexandrine rats were tested. Stimulation periods were of five minutes duration, with three minutes rest interposed between the different stimuli. In most instances, the rats were tested within a few days after being trapped, but in a few cases they were not tested for several weeks. Seven of the wild Norway rats were selected at random and subjected to daily auditory tests for a period of 27 days.

None of the wild Norway or Alexandrine rats showed either the preliminary high states of excitement or the culminating convulsive seizures; nor did they show any fear responses such as retreats from the hissing air-blast, a common reaction of the domesticated rat to this form of stimulation. On the contrary, they exhibited definitely aggressive behavior in attacking and attempting to bite the metal nozzle of the air-blast apparatus.

The most obvious explanation of the absence of audiogenic seizures in the wild rat is that the convulsions may be a characteristic of domestication. In agreement with this explanation Farris and Yeakel[4] have reported that wild Norway rats bred in the laboratory for 19 generations showed an even greater susceptibility to seizures than their albino relatives. It is evident that if the wild rat showed any such response in its natural environment it would not survive very long.

Some of the factors which may influence the appearance of fits under conditions of domestication are: (1) the progressive inbreeding of a sensitivity to sounds of high frequency; (2) dietary deficiencies produced by the laboratory stock diets; (3) the effects produced by confiement in small cages; (4) the lack of practise in meeting new situations; and (5) endocrine changes.

That dietary factors may play an important part we know from the fact that domesticated rats which never before manifested audiogenic seizures show them when placed on a diet deficient either in magnesium,[5] thiamin[6] or pyrodoxine.[7] It is quite possible that many of the stock diets fed domestic rats may be deficient in one or more of the minerals and vitamins which are essential for prevention of convulsive seizures. Some of our studies indicate that Purina dog chow, which is widely used as a stock diet, is deficient in thiamin. It was found that domestic rats on this diet showed the audiogenic seizures with great regularity, but failed to exhibit them when allowed to drink freely from bottles filled with a solution of thiamin chloride. In regard to the wild rats, it may be pointed out that despite their life in burrows, in alleys, yards and cellars, they may actually have a wider and better assortment of foodstuffs, especially of minerals and vitamins found in the earth, than their domesticated brothers and sisters raised in modern laboratories. In trapping several thousand rats we have found them in general to be strong, vigorous and free from signs of dietary deficiency, such as loss of hair, dermatitis, poor teeth, etc., often in spite of heavy infestation with internal parasites.

Some evidence at hand indicates that the lack of experience in meeting new situations may play an important part in the production of seizures in the domestic rats. These rats, bred for many generations in the sheltered environment of laboratory cages, have long been deprived of the opportunity or necessity of meeting and adjusting quickly and adequately to new situations. Wild rats, on the contrary, owe their very existence to their ability to react adequately to constantly changing situations encountered in their environments, and in so doing have developed strong patterns of aggressive behavior. Consequently, the laboratory-bred animals would be more disposed to conflict and breakdown in the presence of novel situations than their wild relatives.

The importance of being able to make any kind of

[1] Aided by a grant to Curt P. Richter from the Committee for Research in Endocrinology.

[2] C. T. Morgan and J. D. Morgan, *Jour. Comp. Psychol.*, 27: 505, 1939.

[3] F. W. Finger, *Am. Jour. Psychol.*, 55: 68, 1942.

[4] E. J. Farris and E. H. Yeakel, *Jour. Comp. Psychol.*, 35: 73, 1943.

[5] H. D. Kruse, E. R. Orent and E. V. McCollum, *Jour. Biol. Chem.*, 96: 519, 1932.

[6] R. A. Patton, H. W. Karn and C. G. King, *Jour. Comp. Psychol.*, 32: 543, 1941.

[7] H. Chick, M. M. El Sadr and A. N. Worden, *Jour. Biochem.*, 34: 595, 1940.

a response to the experimental situation is brought out by the observation that domestic rats show the fits with less regularity when allowed to run back and forth between the main cage and a small adjoining cage, even though the sound stimulus still follows them.[8] In the wild rat the strong aggressive behavior may serve as an energy outlet or a buffer, which prevents the organism from reaching an explosive level.

Whatever the reason for the absence of auditory fits in the wild rats and their presence in the tame domestic rats we have here an interesting example of behavior differences caused by domestication.

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CHANGES IN ACID-SOLUBLE PHOSPHORUS COMPOUNDS IN THE BRAIN IN POLIOMYELITIS[1]

UNTIL very recently the study of chemical and metabolic pathology of the central nervous system in poliomyelitis was entirely neglected. Racker and Kabat[2] demonstrated that the brain tissue of mice infected with poliomyelitis virus showed a decreased rate of anaerobic breakdown of glucose while oxygen consumption was unimpaired. Recent metabolic studies[3] suggest that this change is specific for poliomyelitis and is not produced by other neurotropic viruses. A decreased lactic acid content of the brain in poliomyelitis has been reported.[4]

The present paper is a preliminary report on changes in acid-soluble phosphorus compounds in the brain in poliomyelitis.

Swiss albino mice four to six weeks of age were infected by intracerebral inoculation of poliomyelitis virus of the Lansing strain. When definite paralysis appeared, the mice were sacrificed by immersion in a mixture of solid CO_2 and ethyl alcohol. Normal mice were treated in a similar manner. The mice were stored in a dry ice box for from several days to two weeks and then the brains were carefully removed. Three brains were pooled for each determination to make a total weight of tissue of approximately one gram. Phosphocreatine, adenosine triphosphate and residual organic phosphate were determined by the method of Stone.[5]

The results are presented in Table I. It is evident that there are marked changes in these compounds in poliomyelitis: adenosine triphosphate increases, while phosphocreatine and residual organic phosphate decrease. The value for adenosine triphosphate for normal mouse brain is similar to that reported by Stone[5] while his normal values for phosphocreatine and residual organic phosphate are somewhat higher than those in Table I. Despite considerable variation, the differences between poliomyelitic and normal brain are clearly significant statistically by use of the "t distribution."[6]

TABLE I

THE EFFECTS OF POLIOMYELITIS ON ACID-SOLUBLE PHOSPHORUS COMPOUNDS OF THE MOUSE BRAIN*

	Phosphocreatine	Adenosine triphosphate	Residual organic phosphate
		NORMAL	
	10.8	16.3	23.2
	10.6	14.8	22.2
	9.46	17.0	22.3
	10.5	20.0	22.84
	2.1	17.5	5.2
	6.65	17.1	9.45
	6.83	15.9	25.97
Mean	8.13	16.95	18.74
		POLIOMYELITIS	
	5.55	23.9	0.80
	1.38	28.0	3.20
	2.38	26.5	7.47
	0.63	24.0	2.50
	0.46	22.1	4.14
	5.83	32.7	0.90
	4.59	33.3	1.11
	5.68	15.0	13.32
Mean	3.44	25.71	4.18
t	3.28	3.65	4.5
Per cent. change from normal	−56.6	+51.7	−77.6

* P per 100 grams of brain tissue.

The changes in acid-soluble phosphorus compounds observed in the brain in poliomyelitis can not be explained on the basis of greater autolysis in the infected tissue, since autolysis would decrease rather than increase the adenosine triphosphate content.[5] The intracellular parasite, the virus, might, in the course of its growth and multiplication, break down nucleoproteins of the cell or might interfere with dephosphorylation of adenosine triphosphate to produce an increase of the latter compound in the brain tissue. The marked changes in acid-soluble phosphorus compounds suggest the possibility of a considerable interference with energy mechanisms and carbohydrate metabolism of the neurons by the virus infection.

Summary: Preliminary studies indicate that the content of adenosine triphosphate is greatly increased in the brain of the mouse infected with poliomyelitis virus. On the other hand, phosphocreatine and residual organic phosphate are markedly decreased in the infected brain.

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[8] W. J. Griffiths, *Comp. Psychol. Monog.*, 17: 1, 1942.

[1] Aided by a grant from the National Foundation for Infantile Paralysis. The author is at present with the Division of Chemotherapy, National Institute of Health, Bethesda, Maryland.

[2] E. Racker and H. Kabat, *Jour. Exp. Med.*, 76: 579, 1942.

[3] M. Nickle and H. Kabat. Unpublished observations.

[4] H. Kabat, D. Erickson, C. Eklund and M. Nickle, SCIENCE (in press).

[5] W. E. Stone, *Jour. Biol. Chem.*, 135: 43, 1940.

[6] F. E. Croxton and D. J. Cowden, "Applied General Statistics." New York: Prentice-Hall, Inc., 1940.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF OPENING LYOPHILE TUBES

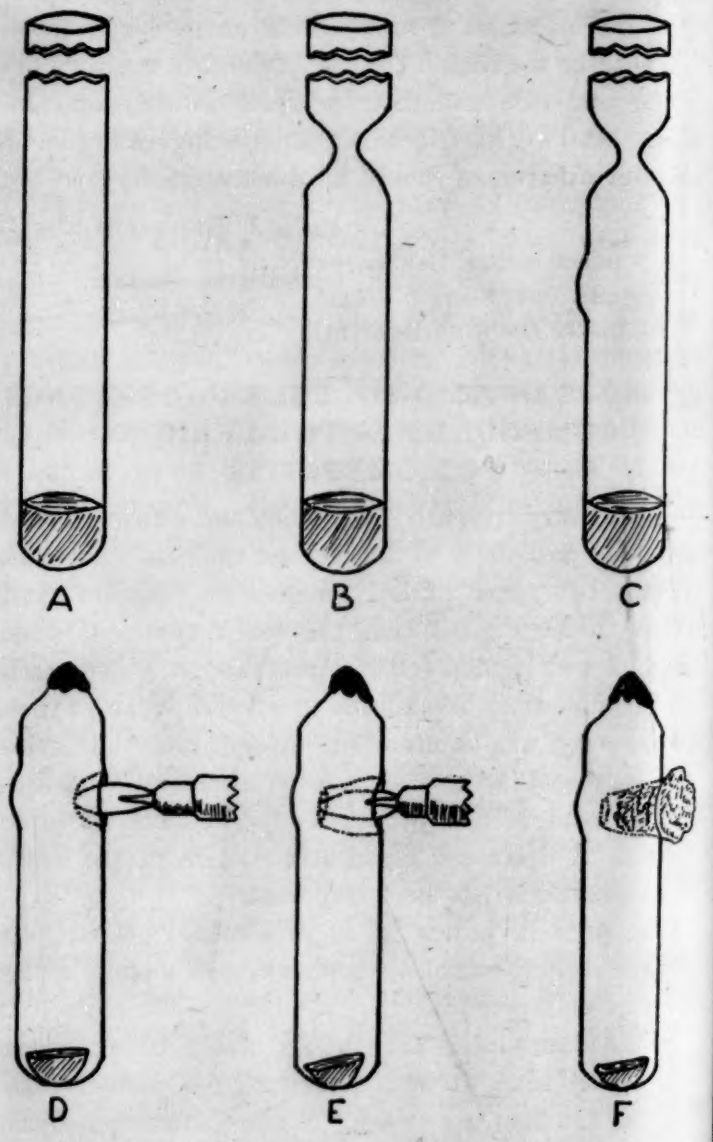
THE difficulty of conveniently and cleanly breaking open vacuum-sealed tubes of dried material led to the development of the following method of preparing, sealing and opening tubes having a diameter of 1.5 cm. The method is undoubtedly applicable to tubes of other dimensions.

The material to be dried is placed in a sterile Pyrex test-tube, 15 cm by 1.5 cm (A), and the cotton plug is pushed about one inch into the tube. The tube is then heated and constricted about 7 cm from the bottom (B). Using a spot flame, a small cup is blown about 2 cm below the constriction (C), and the tube is then attached to the lyophile apparatus. After the material has been thoroughly dried, the tube is sealed at the constriction and the tip is dipped in sealing-wax to prevent entrance of air if scoring of the sealed tip should occur.

When it is desired to open the tube, a spot flame (gas-oxygen) is applied opposite the cup (D) and the vacuum causes atmospheric pressure to force an inverted bubble into the lumen of the tube. The size of this bubble is controlled by rotating the flame. When a suitable diameter has been obtained, the flame is directed toward the point where the break is desired. With proper direction of the flame, the bubble elongates and finally breaks toward the cup (E). The flame is then removed, and a sterile cotton plug is inserted into the "funnel" (F). This procedure for opening the tube requires about ten seconds.

Theoretically, the air which rushes into the tube through the break is sterile, since, at that time, the walls of the funnel are very hot and the flame is still in place. To test this, the following trials were run.

Five tubes, each containing a small agar slant, were treated by this procedure and, after opening, were plugged with cotton and placed in an incubator at 37.5° C. No growth had occurred at the end of one week. Five tubes containing a suspension of a rapidly growing bacillus, and two tubes containing a suspension of *Mycobacterium tuberculosis avium* were all lyophiled and opened as above. Sterile distilled water was pipetted through the funnels into the tubes and the dried material resuspended. The tubes were then tilted horizontally so that the suspension flowed into the cups, and a loop of material was removed from each tube and streaked on agar slants. Growth without contamination occurred on all slants. Two series of ten tubes each, one containing anti-bovine-brucellosis-serum and the other containing anti-swine-brucellosis-serum, both antisera being of known titer, were lyophiled and sealed. Half of the tubes in each series were opened by the regular method of scoring and breaking, and the other half were opened by the method herein described. Upon determining the agglutination titers of the redissolved material, no difference was noted among the various samples.



A noticeable advantage is the fact that the cotton plug is protected by the glass walls of the funnel, and only unusual handling will cause the fluid in the tube to come in contact with the cotton.

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